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## (12) INVENTION SPECIFICATION

### PERTAINING TO A CERTIFICATE OF AUTHORSHIP

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 (71) SA Lavochkin Scientific Production Association  
 (72) Zepenov IA; Zuev VG; Kotlyarov EYu; Serov GP  
 (56) Dan PD, Ray DA. Heat Tubes, Moscow: Energiya  
 Publishers, 1979, pages 172-173.  
 USSR Certificate of Authorship No. 449213, Cl. F 28D  
 15/02, 1972.

#### (54) CONTOUR HEAT TUBE

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(57) Use: In systems for cooling heat-producing devices. Essence of the invention: compensation cavity 6 is connected to evaporator 1 by pipeline 7 with controllable valve 8. The evaporator 1 is connected to condenser 2 by pipeline 3. The thermoelectric cooler 9 is connected to cavity 6 by a cold junction and by a hot junction to the evaporator 1 with hot line 10. Microcondenser 9 is connected to valve 8 through a control unit 11. The latter is designed in the form of a commutation unit. Its normally open contacts are connected into the power supply of the condenser 9 and the normally closed contacts into the power supply of valve 8. 1 dependent claim, 3 figures.

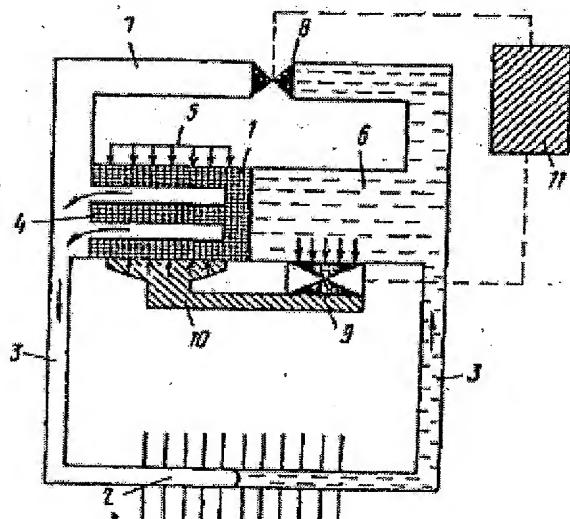


Figure 1

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The invention pertains to heat engineering and can be used in systems for cooling heat-producing equipment.

The objective of the invention is to ensure the possibility of using the contour heat tube as a thermal switch, and also to increase the efficiency of heat transfer during restarting.

Figure 1 shows a diagram of the contour heat tube (CHT).

The latter contains an evaporator 1 and a condenser 2, connected by pipelines 3 (vapor and condensate line). Capillary-porous extension 4 divides the evaporator into two areas: the heat supply zone 5 and the compensation cavity 6. The compensation cavity is connected to the heat supply zone with an additional pipeline 7 with a controllable valve 8. The cold junction of TEMC 9 is thermally connected to the compensation cavity, the hot junction of which is in contact with the heat supply zone through hot line 10. Connection and disconnection of the TEMC and valve is accomplished with control unit 11, designed in the form of a commutation unit, the normally opened contacts of which are connected into the power supply of the TEMC and the normally closed contacts into the power supply circuit of the valve.

Figure 2 shows one of the possible variants of the control unit.

The unit consists of a relay, having normally open and normally closed contacts.

Connection of the relay corresponds to "connection" of the controllable contour heat tube.

Figure 3 shows the heat transmission characteristics of the CHT, illustrating possible operation with low or high efficiency of heat transfer at a fixed temperature head between the evaporator and condenser  $\Delta T_{fix}$ .

According to this characteristic, the CHT, at the same temperature head, is capable of transmitting up to two different heat flux values. During restarting, which occurs under conditions of constant temperature head between the evaporator and condenser, the CHT transmits a minimal heat flux  $Q_{min}$ .

To ensure greater efficiency of the heat transfer, i.e., corresponding to  $Q_{max}$ , it is necessary for the refrigeration capacity of the TEMC to correspond to the condition

$$Q_{TEMC} = C_L \cdot (A \cdot \mu_s \cdot D_s - Q_{min}/r) \times T_{fix} \cdot K1 \quad (1)$$

where  $C_L$  is the heat capacity of the liquid phase of the heat transfer agent,  $J/(kg \cdot K)$ ;

$r$  is the phase transition temperature,  $J/kg$ ;

$D_s$  is the diameter of the pipeline,  $m$ ;

$\mu_s$  is the viscosity of steam,  $Pa \cdot s$ ;

$Q_{min}$  is the minimal flux transmitted by the CHT at  $\Delta T_{fix}$  (determined by the heat transfer characteristic),  $W$ ;

$\Delta T_{fix}$  is the temperature head between the evaporator and condenser,  $K$ ;

$K1$  is a coefficient that allows for the effect of heat inertia;

$A$  is an empirical coefficient, in the general case  $f(Re_{cr}) \approx 1900$ ;

$Q_{TEMC}$  is the refrigeration capacity of the TEMC,  $W$ .

The operating conditions of the TEMC are also determined by the choice of thermal resistance of the hot line according to the condition

$$R_H < (T_{WE} - T_{HJ})/Q_{TEMC} H \cdot \varepsilon \quad (2)$$

where  $T_{WE}$  is the temperature of the wall of the evaporator in the heat supply zone, K;  
 $T_{HJ}$  is the temperature of the hot junction of the TEMC at the assigned refrigeration capacity, K;

$R_H$  is the thermal resistance of the hot line, K/W;

$\varepsilon$  is the efficiency of the TEMC.

The CHT output is as follows.

When valve 8 is open, the steam pressure in the heat supply zone hardly differs whatsoever from the pressure in the compensation cavity and, as a result, heat and mass transfer do not occur, the CHT is "switched off". Closure of the valve permits isolation of the compensation cavity from the hot line zone, as a result of which circulation of the heat transfer agent begins along the pipelines that connect the evaporator 1 to condenser 2. However, according to the heat transfer characteristic of the CHT (Figure 3), high-efficiency or low-efficiency heat transfer is possible. For the available temperature head  $\Delta T_{fix}$ , conditions are established corresponding to  $Q_{min}$  (Figure 3), since startup occurs from zero (or close to zero) heat flux.

The transition to the operating mode that ensures maximum efficiency of the heat transfer  $Q_{max}$ , i.e., the CHT is "switched on", is carried out by connection of the TEMC 9 with valve 8 closed. The latter is accomplished with the control unit, which permits only sequential operation of the TEMC and the valve.

Cooling of the compensation cavity with the TEMC, the refrigeration capacity of which satisfies conditions (1) and (2), leads to a reduction of pressure in the compensation cavity to a value that ensures circulation of the heat transfer agent with a flow rate corresponding to  $Q_{lim}$  (extremum of the heat transfer characteristic of the CHT).

According to Figure 3, the heat transfer capacity of the CHT will be dictated by the available temperature head  $T_{fix}$  and, consequently, the value of the transmitted heat load increases from the value  $Q_{lim}$  to  $Q_{max} \cdot R_{ost}$  of the transmitted heat load, which occurs by additional cooling of the compensation cavity with the condensate entering it.

Use of the invention significantly expands the possibilities for different controllable cooling systems that operate under conditions of arbitrary orientation, significant distance from the heat liberation source from the heat sink, and also for any desired limiting conditions.

## Claims

1. CONTOUR HEAT TUBE, containing a condenser and an evaporator situated in a single housing and connected by steam and condensate lines, with a capillary-porous extension and a compensation cavity positioned on the side of the condensate line, characterized by the fact that, in order to ensure the possibility of using the tube as a heat switch, and also to increase the efficiency of heat transfer during restarting, the compensation cavity is additionally connected to the evaporator by means of a pipeline with a controllable valve, connected to the evaporator on the steam line side and equipped with a thermal electrical microcondensor,

connected to it by a cold junction and with a hot junction to the evaporator by means of a hot line, in which the microcondenser is additionally connected to the valve through the control unit.

2. Tube according to Claim 1, characterized by the fact that the control unit is designed in the form of a commutation unit, the normally open contacts of which are connected into the power supply of the thermoelectric cooler, and the normally closed contacts of which are connected into the power supply to the valve.

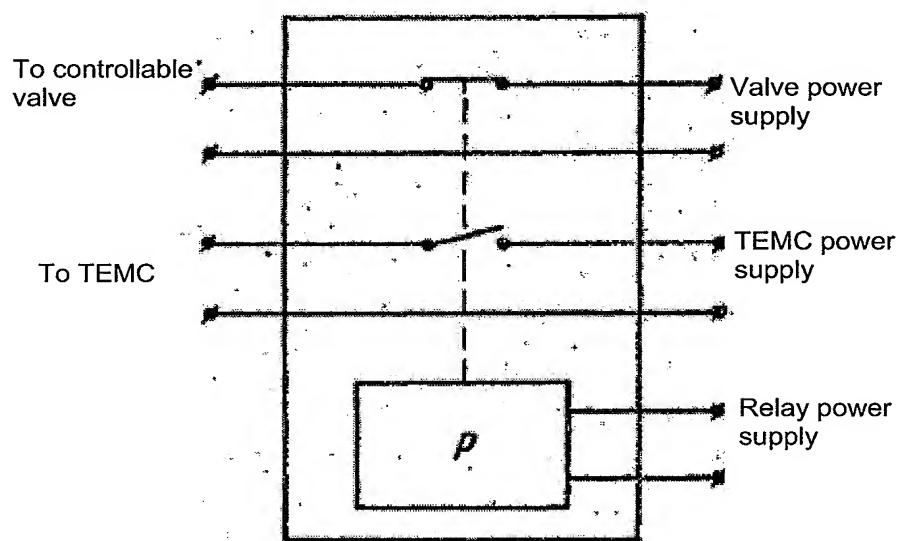


Figure 2

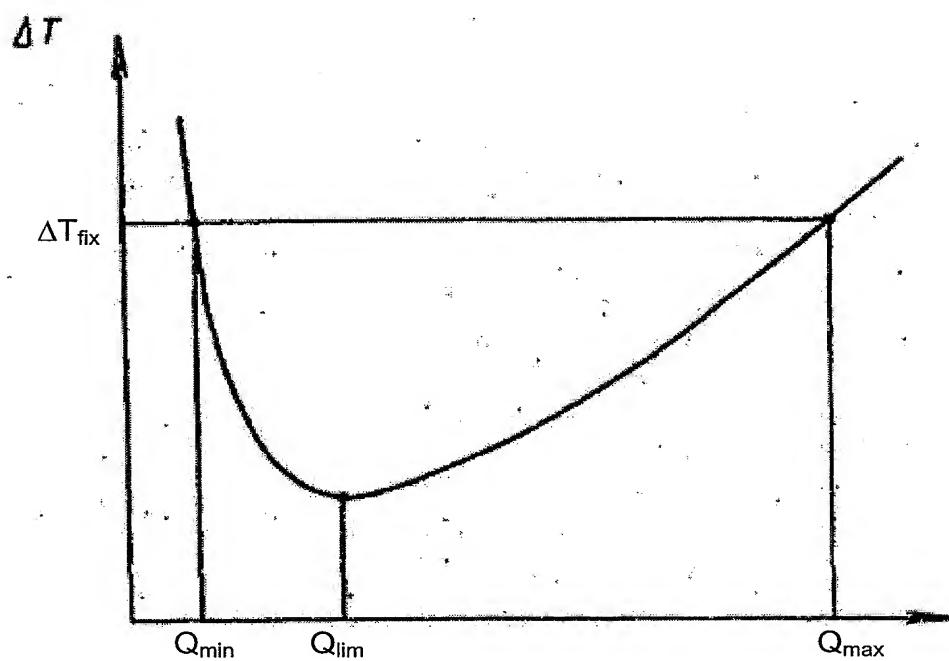


Figure 3

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Translated by:



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